2013

Redesigning Space for Interdisciplinary Connections: the Puget Sound Science Center

Alyce DeMarais

Jeanne L. Narum

Adele J. Wolfson
Wellesley College, Awolfson@wellesley.edu

Redesigning Space for Interdisciplinary Connections: the Puget Sound Science Center

Alyce DeMarais*, Jeanne L. Narum[#] and Adele J. Wolfson[$]

*Associate Professor of Biology at University of Puget Sound and a participant in design of their Science Center.

[#]Director of the Learning Spaces Collaboratory (http://www.pkallsc.org/) and Project Kaleidscope (PKAL) Director Emerita.

[$]Schow Professor of the Natural and Physical Sciences at Wellesley College.

Keywords:

learning space planning, interdisciplinary, learning environment

Mindful design of learning spaces can provide an avenue for supporting student engagement in STEM subjects. Thoughtful planning and wide participation in the design process werekey in shaping new and renovated spaces for the STEM community at the University of Puget Sound. The finished project incorporated Puget Sound's mission and goalsas well as attention to pedagogical principles, andled to connections and integration throughout the learning environment, specifically at the biochemistry and molecular life sciences intersections.

The way that we think about environments for learning has changed radically over the last half century. Whereas buildings used to be considered inert backdrops to the learning that went on within them, they are now seen as essential elements for teaching and learning. The Reggio Emilia philosophy of early childhood education considers the environment to be the "third teacher" [1], as important as instructors and peers, and this is echoed by TorinMonahan in reference to "built pedagogy" [2].

As research on how people learn [3] has shaped the pedagogies adopted in our STEM classrooms, the role of the learning environment has become more central. Even though it is possible to engage students in active learning in all kinds of classroom space, it is also clear that older spaces have many pedagogical assumptions built into them [4] including the role of teacher as owner of knowledge, the idea that learning can happen only in classrooms, and that learning is an individual activity. Overturning these assumptions and creating space that is conducive to welcoming all learners [5] and allows connection and integration of disciplines [6] is now a starting point for discussions of new and renovated space. Even the language of learning spaces is evolving."Neighborhoods"is now a term for describing the connected and adjacent spaces that embrace 24/7 activities for the undergraduate learner: hallways, private corners, niches, studios, commons—as well as 'registrar-assigned' classrooms and labs. Neighborhoods facilitate the nurturing of learners to become self-reflective, to be socialized into a particular community of practices, to become life-long learners.

However, studies on the effects of environmental elements on learning have not necessarily shown strong correlations between particular stylistic changes and student engagement or learning. Beyond the obvious remediation of physical defects such as poor lighting or ventilation, other renovations do not necessarily lead to better learning[7,8]. What does appear to be important is the engagement of all stakeholders in the design process [8, 9]. As summarized in her comments on space as change agent, Diana Oblinger reminds us that "design is a process, not a product" [9].

The example presented in this paper is of a particularly mindful process, and one that is relevant to the molecular life sciences. How mental images of learning spaces are changing is clearly illustrated by this story of shaping and experiencing new and renewed spaces for the STEM community at the University of Puget Sound, a national liberal arts college in Tacoma, Washington. This is a story about how an engaged faculty, together with administrative colleagues and a team of design professionals, arrived at a set of design objectives that reflected the University's vision and goals as well as their awareness of the future of research and learning in STEM fields, to:

- Give science greater prominence on the Puget Sound campus
- Create an inviting home for the sciences within the Puget Sound community
- Make the exploration of science—the doing of science—visible
- Create places for the doing of science and for the larger Puget Sound community that encourage interactions—planned and spontaneous.

The theme of "connections" permeates the planning, design, and implementation process, in ways that resonate with the current generation of students [10]. The design principles that emerged through this planning suggest that making connections became the touchstone against which decisions were calibrated.

Through a three-stage construction process, starting in 2005, the University updated the science center by constructing a new wing and renovating the existing structure. The original Thompson Hall, a four-floor science building, was built in the 1960s. The U-shaped edifice was home to the five science and math departments: biology, chemistry, geology, mathematics/computer science, and physics. The building also housed the Slater Museum of Natural History, tucked away on the third floor of the south wing.

Thompson Hall, as it then was, provided a nice mix of classrooms, teaching and research laboratories, offices, and support spaces. Each room, however, was closed off from the hallway by a windowless door and thick walls. Thompson Hall was home to the largest lecture hall on campus—a two-story, stadium-seating hall with a fixed bench in the front. The hall dwarfed the classes held in the room but was a stark yet serviceable venue for campus lectures and the popular annual Chemistry Magic Show. Perhaps due to the building's design, there was little spontaneous interaction, particularly among inhabitants of opposite wings or among visitors to the building.

By the early 2000's, Thompson Hall was in need of a transformation. Changes in science and math pedagogy over the years resulted in the need for more teaching laboratory space. With almost every science class including a laboratory component, double- and triple-scheduling of the laboratory spaces was becoming untenable. Puget Sound has a strong commitment to research and there was not enough research laboratory space for the number of faculty members or to support the vigorous student research program.The existing laboratory spaces had been built to 1960's codes and were in need of updating. Gone were large lecture classes, replaced by smaller classes in need of more intimate teaching spaces. Finally, the Slater Museum of Natural History needed a more prominent and accessible location.

Connections in Planning

Connections started well before construction. The community began an extensive planning process that included site visits by faculty members and administrators to other institutions, Project Kaleidoscope workshops, and a highly involved faculty. Early in the planning process the science faculty reaffirmed its commitment to the existing science departments and programs. Faculty members also expressed a desire to keep all the science departments together rather than constructing a separate building for a subset of departments. Through departmental meetings and discussions among representatives from departments and programs, the faculty identified overlapping interests, approaches, and connections among the disciplines. These connections are illustratedin the diagram in Figure 1. Representative faculty members from all science departments were involved throughout the construction

process and served as liaisons for the departments. A faculty member served as liaison to the overall project.

SRG Partnership of Portland, Oregon, was the lead architectural firm for the Puget Sound Science Center project. The architects and designers had good experience in designing science spaces and laboratories and bringing a sustainable approach to their projects. The SRG practice of collaboration with academic partners throughout the design process reinforced the interactive nature of planning for this project.

Physical Connections

The newly constructed Harned Hall was built along the top of the "U" of Thompson Hall, connecting the two side wings and enclosing a courtyard. Considering the appropriate diversity, size and affordances of spaces within Harned Hall was a critical planning challenge: where were the overlaps—between disciplines, between lecture and lab, between settings for formal and informal learning?

Harned Hall added much needed teaching laboratory spaces as well as common areas such as the microscopy suite, the shop, and the animal facility. The flow of interactions now moves seamlessly from one wing of Thompson Hall through Harned Hall to the other wing of Thompson. A beautiful foyer connects the campus and neighborhood with Harned Hall and the courtyard. The courtyard connects with the three wings of Thompson Hall. Within the buildings themselves, connections are made through two spiral staircases. One spans all three floors of

Harned Hall and is part of the central foyer. The other joins the two floors of the Mathematics/Computer Science Department, providing easy access in the middle of the "long" wing of Thompson Hall.

Connections in Teaching and Pedagogy

The building was planned and designedspecifically to encourage connections among the disciplines. In particular, the co-localization of the teaching laboratories and support spaces associated with the biochemistry, cell biology, and molecular biology areas were carefully designed to facilitate interdisciplinary pedagogy. These laboratory spaces inhabit one corner of Thompson Hall, a corner close to Harned Hall, and extend along most of one wing. A floor plan is shown in Figure 2.

The Genetics teaching laboratory is next to the Biochemistry/Molecular Biology teaching laboratory and the two laboratory spaces are united by a door. Two shared equipment rooms flank the labs. One room is dedicated to equipment such as a NanoDrop Spectrophotometer, PCR machines, and a gel documentation system. The second equipment room houses incubators, freezers, balances, and the like. All the rooms open onto a common area, with a white board, that provides a spontaneous meeting area as well as a location to keep food and drink.

Traveling down the hall from the Genetics/Biochemistry/Molecular suite, one comes to a teaching laboratory for Microbiology and Molecular Biology and Physiology of Plants. A large prep room connects this laboratory with the Cell

Biology teaching laboratory. The prep room contains shared equipment plus an ancillary cell culture room. A cold room is placed just beyond the Cell Biology lab. Chemistry faculty research laboratories are located across the hall from the Microbiology/Molecular Biology and Cell Biology teaching labs. Chemistry teaching labs and equipment rooms, as well as open interactive spaces, are located down a short hallway on the other side of the Genetics/Biochemistry/Molecular suite.

Intentional design of learning spaces for Biochemistry, Cell and Molecular Biology, and Genetics supports the student-centered, active-learning pedagogies employed to facilitate student learning in the sciences [11]. Multi-stage independent projects founded in problem-based learning are facilitated by dedicated laboratory and shared equipment spaces. Students work cooperatively within the framework of their given laboratory section to address problem-based laboratory projects. Interactions among faculty and students from different classes are enhanced through encounters that occur, often outside of the scheduled laboratory session, as students work on their projects. During these encounters, concepts and techniques are readily discussed by students from different classes—a biochemistry student with a student from genetics, for example. Students working on independent research also use the support areas and equipment located near these teaching labs, lending an added dimension to student interactions in these spaces.

Co-localization of these teaching laboratories and support spaces corresponded with the implementation of new majors in Biochemistry and in Molecular and

Cellular Biology at Puget Sound. In the past five years, the numbers of majors in these areas has more than doubled, as shown in Table 1. While this trend has been seen in these areas of study across the nation, many Puget Sound students cite the buildings and shared spaces as one of the aspects that drew them to Puget Sound.

Other aspects of the building were carefully designed to encourage connections. Faculty research laboratories and teaching laboratories are located in the same wings. For example, chemistry faculty research labs are located across the hall from the Microbiology/Cell Biology teaching laboratories. Numerous windows facilitate interaction and invite connections within the teaching and research laboratory spaces. In addition, the windows invite passers-by to experience dynamic science teaching and learning.

Faculty offices are located in suites, encouraging easy interaction among faculty members, students, and staff members. Departmental offices and support rooms are located in the suites as well.

Throughout the buildings, public interaction spaces provide well-lit and inviting areas for study, visiting, and both spontaneous and planned meetings. The second and third floors of Harned Hall include long colonnades, faced by floor-to-ceiling windows looking over the courtyard (see Figure 3). The colonnades and alcoves throughout Harned and Thompson Hallshold seating areas and tables. Interactive

spaces allow students to work together outside their scheduled classes and labs, as was anticipated in the design phase.

All of these design elements support connections in pedagogy. Students and faculty members report thatthe richness of learning is enhanced by the proximity of classrooms and laboratories and interactions among the students. Ready access to shared equipment spaces and interactive spaces provide opportunities for pedagogical discussions among students, faculty, and staff.

Connections and Community

The connections engendered by careful design encourage a sense of community in three broad areas: within the sciences, across campus, and with the greater community. Connections with teaching and learning in the sciences encourage several high-impact practices and experiences that predict growth on wide-variety of student outcomes [10,12]. Office suites, collaborative workspaces, accessible interactive spaces, and "open" labs foster high-quality non-classroom interactions among students and faculty members. Teaching lab spaces dedicated to specific classes allow faculty members to implement laboratory curricula that support students in integrating ideas and information, leading to higher-order learning.

The open design and inviting spaces of the science center foster connections with the broader campus community. The teaching spaces are used for classes from departments and programs across campus. Students, faculty, and staff from all

areas meet at the Oppenheimer Café coffee shop located in the courtyard. The Harned Hall colonnade and courtyard (weather permitting) are used for campus events.

Interactions extend to the broader community outside the campus as well. Community members and visitors to the campus attend events and frequent the coffee shop. The new, prominent location of the Slater Museum of Natural History, just off the courtyard, facilitates educational and research connections with community members including K – 12 school groups. Public displays will soon be available outside the Slater Museum, inviting visitors to experience Northwest natural history and education first-hand.

Additionally, the facility is a "laboratory for learning"in ways visible and invisible. The invisible is the system of 'night flush' of air, eliminating the need for air conditioning; visible are the sun shades that add both an aesthetic quality to the exterior and serve as tools for controlling temperatures. The most immediate sense that this is a laboratory for learning surfaces while walking through the spaces, with 'scientific' art featured in hallways and atria—all designed, and in some cases produced, by Puget Sound faculty and student artists.

Connecting Art and Science

Beyond the scientific art mentioned above, a discussion of the science center at Puget Sound would not be complete without mentioning the connections

betweenscience and art. Throughout the planning, design, and construction phases of the project specific decisions were made to meld art and science into the design of Harned Hall and the remodeled Thompson Hall.

The buildings are home to a number of "science on display" features and artwork. For example, Harned Hall includes two wall mosaics that span two floors and are visible in full from the courtyard and Thompson Hall. Constructed of 4-inch square tiles, one mosaic represents the golden rectangle and the other the orbits of the solar system planets. The bricks in the courtyard represent Sierpinski's Carpet. A two-story analemma connects art with science through the reflection of the sun's rays to reveal time, date, and season. From the floor tiles to the science-themed artwork on the walls, science is visible to all.

And the annual Chemistry Magic Show is now held in Puget Sound's Schneebeck Concert Hall, taking science out of the science center and onto the campus—building further connections.

Faculty and student observations confirm that this building has made a difference. Its potential for transforming the STEM learning environment at the University of Puget Sound was understood by the planning team from the beginning. They identified critical questions about students and about the world in which students will live and work upon graduation and about the science of the future. In the process of planning they dissolved all sorts of existing boundaries. They achieved

spaces that are permeable, that have become a central part of the overall physical organization of the campus and that will serve generations of Puget Sound faculty and students.

References

[1] Bruce Mau Design, VS Furniture, and OWP/P Architects (2010) *The Third Teacher*. Abrams, New York NY.

[2] T. Monahan (2002) Flexible Space and Built Pedagogy: Emerging IT Embodiments.Inventio 4, 1-19.

[3] J.D. Bransford, A.L. Brown, and R.R. Cocking, eds (2000) *How People Learn: Brain, Mind, Experience, and School.* National Academies Press, Washington DC.

[4] N.V.N. Chism and D.J. Bickford, eds(2002) *The Importance of Physical Space in Creating Supporting Learning Environments*. New Directions in Teaching and Learning, no 92.Jossey-Bass, San Francisco CA.

[5] C.C Strange and J.H. Banning JH (2000)*Educating by Design: Creating Campus Learning Environments that Work*. Jossey-Bass, San Francisco.

[6] C. Lomas and D.G. Oblinger (2006) Student Practices and Their Impact on Learning Spaces, in: *Learning Spaces* (Obinger DG, ed) EDUCAUSE.

[7] J. Bernard (2012) *A Place to Learn: Lessons from Research on Learning Environments*. UNESCO Institute for Statistics, Montreal, Quebec.

[8] S. Higgins, E. Hall, K. Wall, P. Woolner, and C. McCaughey (2006) *The Impact of School Environments: A Literature Review.* Design Council, University of Newcastle Upon Tyne.

[9] D.G. Oblinger DG (2006) Space as Change Agent, in: *Learning Spaces* (Obinger DG, ed) EDUCAUSE.

[10] G.D. Kuh, J. Kinzie, J.H. Schuh, and E. J. Whitt (2005) *Student Success in College: Creating Conditions that Matter.*Jossey-Bass, San Francisco CA.

[11] T. Eberlein, J. Kampmeier, V. Minderhout, R.S. Moog, T. Platt, P. Varma-Nelson, and H.B. White (2008) Pedagogies of engagement in science: a comparison of PBL, POGIL, and PLTL. BiochemMolBiolEduc 36, 262-273.

[12] Wabash National Study of Liberal Arts Education (2013) High Impact Practices Summary. http://www.liberalarts.wabash.edu/storage/High-Impact_Practices_Summary_2013-01-11.pdf

Table 1: Number of Science Majors before and after renovation

Number of Majors		
Major	2007 – 2008	2011 – 2012
Biochemistry	8	21
Biology	29	32
Chemistry	11	5

Molecular and Cellular Biology	11	25

Figure legends:

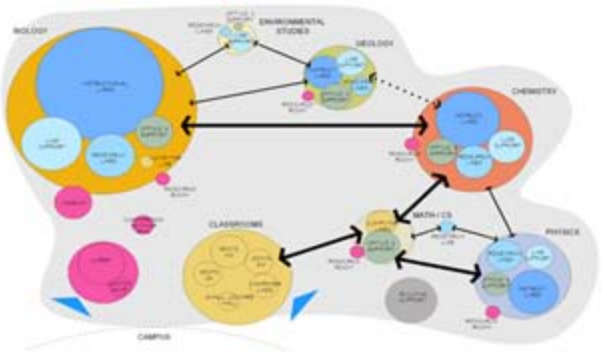
Figure 1 .Connections among the STEM disciplines at Puget Sound. Planning for the new and renovated sections of the science center included analysis of the interrelationships of the STEM departments and programs and the space needs associated with the programs.

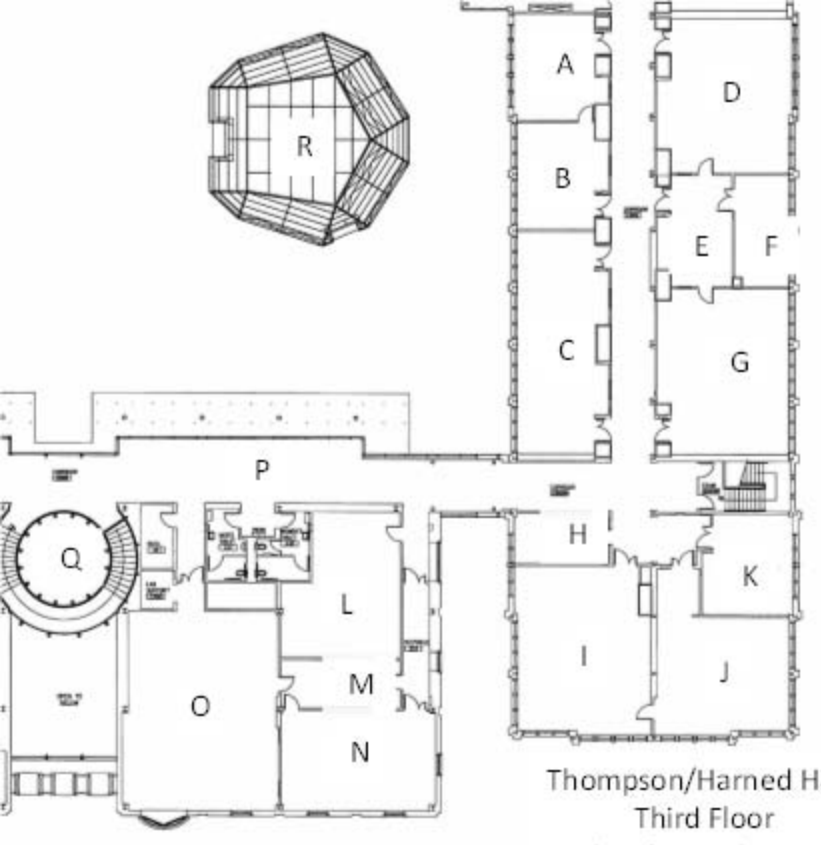
Figure 2. Floor plan of the southwest corner of the Puget Sound Science Center. Teaching laboratories and support spaces for biochemistry/molecular biology-related courses are co-located and in close proximity to chemistry teaching and research laboratory spaces.

A Chemistry Research Laboratory
B Chemistry Research Laboratory
C Chemistry Research Laboratory
D Cell Biology Teaching Laboratory
E Cell Biology/Microbiology Equipment Room
F Tissue Culture Room
G Microbiology/Plant Molecular Biology Teaching Laboratory
H PCR/Gel Documentation Equipment Room
I Genetics Teaching Laboratory
J Biochemistry/Molecular Biology Teaching Laboratory
K Biochemistry/Genetics/Molecular Biology Equipment Room
L Chemistry Storage
M Chemistry Instrumental Computing Laboratory
N Chemistry Instrument Room
O Organic Chemistry Teaching Laboratory
P Colonnade Interactive Space

Q Staircase
R Oppenheimer Café in the Brown Family Courtyard

Figure 3. Third Floor Harned Hall Colonnade. Interactive spaces such as the colonnade provide opportunities for students, faculty, and staff to work together in planned and spontaneous ways in proximity to the teaching and research laboratories.


BIOLOGY
ENVIRONMENTAL STUDIES
GEOLOGY
CHEMISTRY
MATH / CS
PHYSICS
CLASSROOMS
CAMPUS



Thompson/Harned Halls
Third Floor
Southwest Corner